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LEUKOPENIA AND LEUKOCYTOSIS IN SPLENECTOMIZED RABBITS

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In a previous report¹ it was shown that shortly after the intravenous injection of killed bacteria in rabbits there results a marked decrease in the leukocytes involving chiefly the polymorphonuclear elements, and that simultaneously the blood from the spleen and liver contain an enormously increased number of leukocytes, especially the polymorphonuclears. In view of this observation it seemed of interest to make a similar study on splenectomized rabbits.

As a rule the blood of normal rabbits from other sources than the splenic parenchyma and the veins of the principal organs contains a fairly uniform number of leukocytes; the blood from the organs except the spleen containing slightly more than that from the spleen and several times the number in the general blood stream.

Eight adult rabbits were used. Leukopenia was induced by the intravenous injection of 40-60 million of dead typhoid bacilli or streptococci, the injections being made from 1-94 days after splenectomy (Table 1). Leukopenia would develop from 3-10 minutes after the injection. In Rabbit 2 a drop from 15,150 to 1,300 leukocytes in each c.mm. of the peripheral blood occurred within 4 minutes. During the leukopenia the number of leukocytes in the blood in the bone marrow were 2-5 times as many, in the superior mesenteric vein and artery and in the liver parenchyma twice as many, in the jugular vein 4 times as many, and in the hepatic and portal vein twice as many as in the peripheral blood; the number in the blood of the muscles, the kidney parenchyma, the left and right ventricles, the lung parenchyma, the hepatic artery, the superior and inferior vena cava, and the axillary artery corresponded to that in the ear vein.

In Rabbits 2, 5, 7, and 9 there occurred a decrease in the number and proportion of the polymorphonuclear leukocytes in the blood from all sources, including that from the bone marrow, which was not the

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case in the nonsplenectomized rabbits. In Rabbits 1, 8, and 10 there occurred a decrease in the number and proportion of the polymorphonuclear leukocytes in the blood from all sources examined except from the bone-marrow, the liver and the lung parenchyma. In the case of the liver and lung parenchyma the proportion of the polymorphonuclear elements dropped synchronously with the drop in the blood from other sources; but in the case of the bone-marrow the proportion of these elements remained normal. In Rabbit 6, the injection being made the day following splenectomy, there occurred only a slight drop in the number and proportion of the polymorphonuclear leukocytes in the blood from all sources examined, suggesting an unbalanced condition of the hemopoietic system on account of the splenectomy. In the other rabbits the splenectomy had been made 7-94 days before the injection.

TABLE 1
LEUCOCYTE COUNTS IN SPLENECTOMIZED RABBITS DURING LEUKOPENIA FOLLOWING INTRAVENOUS INJECTION OF BACTERIA

	Rabbit 8	Rabbit 9	Rabbit 10	Rabbit 7	Rabbit 6	Rabbit 5	Rabbit 2	Rabbit 1
Bacterial injection.....	60 million living strep- tococci 57	40 million dead strep- tococci 32	60 million dead typhoid bacilli 8	60 million dead typhoid bacilli 7	60 million dead typhoid bacilli 1	50 million dead typhoid bacilli 14	60 million dead typhoid bacilli 9	60 million dead typhoid bacilli 94
Days since splenectomy								
Leukocytes in blood of ear vein before injection.....	12,500	9750	10,300	9850	13,000	10,850	15,150	11,500
Leukocyte counts during leukopenia:								
Ear vein.....	.....	5000	1750	2250	3000	4150	1300	3300
Bone marrow.....	44,200	7700	8400	4850	6850	7650	2850	6050
Muscle.....	.....	.....	.....	.....	.....	.....	.....	3100
Sup. mesent. vein.....	.....	.....	.....	5250	4050	6650	3000	4000
Sup. mesent. artery....	.....	.....	.....	4750	2200	6100	2600	2500
Liver.....	20,300	9500	5100	5450	2200	10,400	5000	12,150
Kidney.....	.....	.....	2600	.....	.....	.....	.....	4450
Left ventricle.....	.....	.....	1200	5000	3150	2400	1150	2200
Right ventricle.....	.....	.....	1500	4350	2600	2800	3100	1300
Lung.....	11,650	4750	1450	5700	4550	5800	1600	3500
Jugular vein.....	.....	.....	4350	.....	.....	.....	.....	18,900
Hepatic vein.....	.....	.....	.....	.....	.....	.....	4500	.....
Hepatic artery.....	.....	.....	.....	3400	.....	4950	.....	.....
Sup. vena cava.....	.....	.....	.....	8300	3550	4100	4550	.....
Inf. vena cava.....	.....	.....	.....	3450	3700	4700	.....	.....
Portal vein.....	.....	.....	.....	5500	.....	.....	.....	.....
Left axil. vein.....	.....	5450	.....	.....	.....	.....	.....	.....

In all the rabbits the proportion of small mononuclear leukocytes was greatly increased, but the actual number remained practically normal, except in Rabbit 6 (injected one day after the splenectomy); in this case there occurred a decrease. No material change was noted as to the large mononuclear leukocytes.

TABLE 2
DIFFERENTIAL COUNTS OF LEUKOCYTES DURING LEUKOPENIA IN SPLENECTOMIZED RABBIT
(TABLE 1, RABBIT 2)

Source and Time	Leuko- cytes per C Mm	Differential Counts								Remarks
		Poly- morpho- nuclear		Small Lympho- cytes		Large Lympho- cytes		Mast Cells		
		No.	%	No.	%	No.	%	No.	%	
Left ear vein 1 day before splenectomy.....	12,000	3538	29	6588	54	1708	14	244	2	13 to 23 minutes after injec-
Left ear vein 1 day after splenectomy.....	15,150	4242	28	6666	44	2121	26	303	2	
Left ear vein 9 days after splenectomy.....	5950	2737	46	1904	32	1071	18	238	4	
Left ear vein 5 minutes after injection of 60 mil- lion killed typhoid bacilli..	1300	0	0	1144	88	143	11	13	1	
Bone-marrow.....	2850	200	7	2280	80	199	7	171	6	
Sup. mes. vein.....	3000	30	1	2310	77	420	14	240	8	
Sup. mes. artery.....	2600	0	0	1716	66	520	20	364	14	
Liver.....	5000	150	3	4000	80	250	5	600	12	
Lung.....	1600	32	2	1280	80	144	9	144	9	
Hepatic vein.....	4550	228	5	3822	84	364	8	136	3	
Left ventricle.....	1150	69	6	920	80	23	2	138	12	
Right ventricle.....	3100	31	1	2294	74	527	17	248	8	
Sup. vena cava.....	4550	136	3	3913	86	409	9	91	2	

In several instances the lungs examined were normal; a differential count of the leukocytes in cross-section of an artery showed 104 polymorphonuclear leukocytes and 218 mononuclear leukocytes; the count in a large vein was polymorphonuclear leukocytes 2, mononuclear leukocytes 45. In some instances marked congestion of the capillaries was present without noticeable increase of leukocytes or edema.

No increase in the number of leukocytes was noted in the liver. Bacteria were not seen. The large blood vessels contained largely lymphocytes, there being a slight preponderance of the polymorphonuclear leukocytes in the small vessels. A differential count of the leukocytes in a medium sized artery showed 45 polymorphonuclear and 50 mononuclear cells.

The bone-marrow occasionally showed moderate hyperemia and hyperplasia; the giant cells appeared normal.

Kidneys, lymph nodes, parotid and thymus glands appeared normal.

The pharyngeal mucosa showed marked infiltration of the submucosa and subjacent areolar tissue with polymorphonuclear leukocytes.

During the leukocytosis in splenectomized rabbits from intravenous injections of dead bacteria there occurred no appreciable variation in the relation of the various elements from that during the same stage in

nonsplenectomized rabbits. There occurs a marked general increase in the total number of leukocytes, as well as in the number and proportion of the polymorphonuclear cells, the increase being least in the blood from the left ventricle. The number of small and large lymphocytes was not appreciably increased in the blood from any of the sources studied, but the blood from both sides of the heart contained fewer of these elements than the blood from the other sources. The mast cells were generally slightly increased over the normal.

TABLE 3
LEUKOCYTE COUNTS DURING HYPERLEUKOCYTOSIS IN SPLENECTOMIZED RABBITS

Source and Time	Total Leuko- cytes per O Mm	Differential Counts							
		Polymorpho- nuclears		Small Mononuclears		Large Mononuclears		Mast Cells	
		No.	%	No.	%	No.	%	No.	%
Ear vein 24 hours before splenectomy.....	9750	1755	18	5168	53	1170	12	1657	17
Ear vein 24 hours after splenectomy.....	8900	3847	43	2225	25	1602	18	1246	14
Ear vein before intra- venous injection of 40 million dead typhoid bacilli.....	10,750	6128	57	3117	29	1290	12	215	2
24 hours after injection of typhoid bacilli:									
Left ear.....	45,300	38,505	85	3171	7	3171	7	453	1
Bone marrow.....	39,500	28,885	73	5135	13	4740	12	790	2
Sup. mes. vein.....	32,000	25,600	80	2560	8	3520	11	320	1
Sup. mes. artery....	35,500	29,320	84	3905	11	1775	5	0	0
Liver.....	32,200	24,150	75	4508	14	3542	11	0	0
Lung.....	29,700	23,166	78	3564	12	2376	8	594	2
Left ventricle.....	19,900	15,711	79	1090	10	1791	9	398	2
Right ventricle.....	24,200	20,086	83	1936	8	1694	7	484	2
Sup. vena cava.....	29,800	21,153	71	5364	18	2384	8	894	3
Inf. vena cava.....	22,400	17,472	78	2688	12	2240	10	0	0

CONCLUSIONS AND SUMMARY

The principal result from this study would seem to be the observation that there is no variation in the reaction of the leukocytes in splenectomized rabbits from that in nonsplenectomized rabbits, after intravenous injections of dead bacteria. In both instances a leukopenia occurs within a few minutes following the injection, followed a few hours later by a marked leukocytosis. The length of time elapsing between the splenectomy and the injection apparently has no bearing on the severity of the reaction. There seems to be a tendency to a slight increase in the total number of leukocytes following splenectomy.

The leukocytes in the blood from the bone-marrow and liver parenchyma during the leukopenia were decreased somewhat, except

in one case (Rabbit 8), in which there was a marked increase in the total number and also in the proportion and number of polymorphonuclear cells. This rabbit, however, received an injection of living *Streptococcus viridans*, while the other rabbits received injections of dead hemolytic streptococci and typhoid bacilli.

The presence of large numbers of polymorphonuclear cells in the sections of the peripharyngeal tissues during leukopenia may be explained as due to the local irritating action of the ether employed for anesthesia.

No satisfactory explanation is apparent as a result of this study for the fate of the polymorphonuclear cells during the leukopenia occurring in splenectomized rabbits following intravenous injections of bacteria.